

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
17 June 2004 (17.06.2004)

PCT

(10) International Publication Number
WO 2004/050564 A1

(51) International Patent Classification⁷: C02F 3/06, 3/10

(21) International Application Number:
PCT/KR2002/002268

(22) International Filing Date: 2 December 2002 (02.12.2002)

(25) Filing Language: Korean

(26) Publication Language: English

(71) Applicants (for all designated States except US): KOREA INSTITUTE OF CONSTRUCTION TECHNOLOGY [KR/KR]; 2311, Daehwa-dong, Ilsan-gu, Gyeonggi-do 411-410 (KR). TOMDUCK SYSTEM CO., LTD. [KR/KR]; 4F, 125-1, Yangjae-dong, Seocho-gu, Seoul 137-130 (KR).

(72) Inventors; and

(75) Inventors/Applicants (for US only): KIM, Young-Sug [KR/KR]; #802-203, Dongsung Apt., 1476 Tanhyeon-dong, Ilsan-gu, Gyeonggi-do 411-320 (KR). LEE, Moon-Hyoung [KR/KR]; #104-106, Garam

Apt., 735, Irwon-dong, Gangnam-gu, Seoul 135-230 (KR). JANG, Hong-Kyu [KR/KR]; #901-301, Wooseong Apt., Gaepo 1-dong, Gangnam-gu, Seoul 135-241 (KR). CHANG, Chung-Hee [KR/KR]; #3-606, Lucky Apt., Seoksu 2-dong Manan-gu, Anyang-si, Gyeonggi-do 430-706 (KR). GEE, Chal-Sung [KR/KR]; 2311, Daehwa-dong, Ilsan-gu, Gyeonggi-do 411-410 (KR).

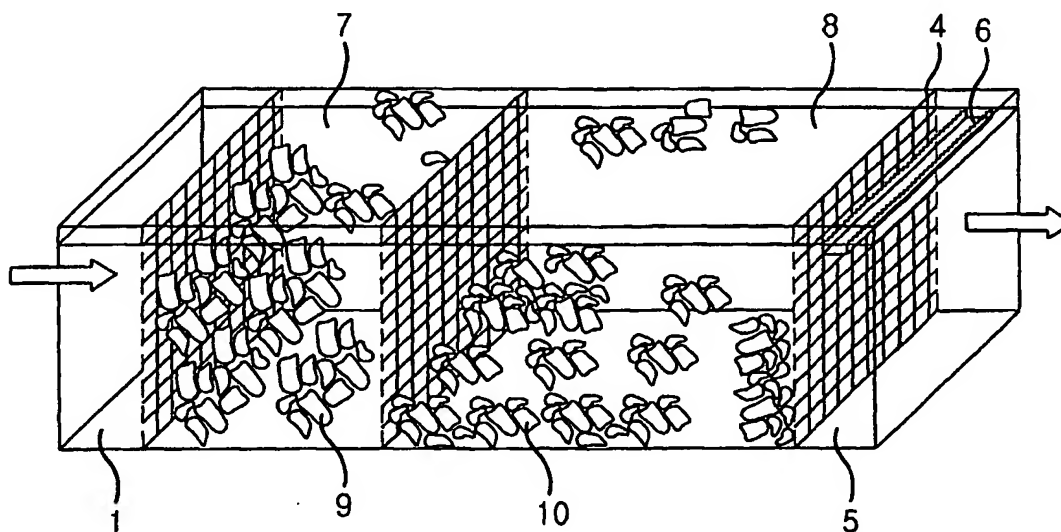
(74) Agent: SHINSUNG PATENT FIRM; Haecheon Bldg., 741-40, Yeoksam 1-dong, Kangnam-gu, Seoul 135-924 (KR).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: APPARATUS AND METHOD FOR PERFORMING TERTIARY TREATMENT OF SEWAGE BASED ON POROUS FILTERING MEDIA



(57) Abstract: Provided is an apparatus and method for performing tertiary treatment of sewage based on porous filtering media. The apparatus for performing tertiary treatment of sewage based on porous filtering media includes a reaction tank for receiving effluent wastewater from a primary settling tank; and porous filtering media, which is located in the reaction tank and has a predetermined size of surface area and opening, for settling suspension in the effluent wastewater and removing organic matter and nutritive salts included in the suspension.

WO 2004/050564 A1

WO 2004/050564 A1



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SI, SK,
TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

5/pets

10/537050

JC20 Rec'd PCT/PTO 02 JUN 2005

APPARATUS AND METHOD FOR PERFORMING TERTIARY TREATMENT OF
SEWAGE BASED ON POROUS FILTERING MEDIA

Technical Field

5

The present invention relates to an apparatus and method for performing a tertiary treatment of sewage by using porous filtering media to purify effluent wastewater from a settling basin of a sewage disposal plant and apply the water to wastewater reclamation and reusing system; and, more particularly, to an apparatus and method for performing a tertiary treatment of sewage by using porous filtering media, which can remove suspended solids, organic matters and nutritive salts included in the effluent wastewater from a secondary settling basin of a sewage disposal plant simultaneously by filling a settling and filtering basin with porous filtering media having large surface area and opening.

20 Background Art

Generally, sewage includes such pollutants as solids, organic matters, nitrogen and phosphorous. Sewage purification is processed in three steps based on the method of treatment: a primary treatment, a secondary treatment and a tertiary treatment. In the primary treatment, suspended solids that can be precipitated easily are removed physically. In the secondary treatment, which is a main sewage treatment step, dissolved organic matters and organic solids are removed. In this step, biological methods are used usually. In the tertiary treatment, organic matters and nutritive salts that have not removed in the secondary treatment are removed by using physical, chemical and biological treatment methods.

35 In the biological secondary treatment, one of the most popular methods is an activated sludge method, which aims for an organic removal efficiency of 90% in average.

However, since the biological secondary treatment normally operating has a limitation in removing the pollutants of the wastewater, the tertiary treatment needs to be performed to produce water of a good quality.

5 In the tertiary sewage treatment, following methods are used based on the sorts of materials to be removed. If organic matters including suspended solids should be removed from sewage, such methods as rapid sand filtering, coagulating precipitation and membrane separation are used.
10 If nitrogen of nutritive salts is to be removed, a biological method of nitrification and denitrification is used. If phosphorous should be removed, coagulating precipitation and other biological methods, a biological nitrogen and phosphorous removal method, and their
15 modifications are widely used.

 If rapid filtering method is used, the quality of the purified wastewater is relatively fine. However, this method has a problem in maintaining the sewage treatment facility. For example, backwashing should be frequently
20 performed. In case of membrane separation method, it is not appropriate for large-size sewage disposal facilities, because it costs a great deal of money to construct and maintain the facilities. Besides, it requires an additional reaction tank and high technology to remove
25 phosphorous and nitrogen and maintain the sewage treatment facility.

Disclosure of Invention

30 It is, therefore, an object of the present invention to provide an apparatus and method for performing a tertiary treatment on sewage by using porous filtering media, the apparatus and method being capable of removing nitrogen and phosphorous in the effluent wastewater from a
35 settling basin, as well as suspended solids and organic matters, by filling a settling and filtering basin with porous filtering media having large surface area and

openings to maximize effective surface area, and supplying oxygen and ozone thereto additionally.

It is another object of the present invention to provide an apparatus and method for performing a tertiary
5 treatment on sewage by using porous filtering media, which can remove organic matters and nutritive salts included in the effluent wastewater of the settling basin simultaneously in order to apply the purified effluent water to a wastewater reclamation and reusing system for
10 various usages by optimizing physical, chemical and biological reactions.

It is another object of the present invention to provide an apparatus and method for performing a tertiary treatment on sewage by using porous filtering media, which
15 can meet the quality goal of the effluent water from the tertiary treatment stably at low facility construction and maintenance costs with simple sewage treatment process.

In accordance with one aspect of the present invention, there is provided an apparatus for performing a
20 tertiary treatment of sewage using porous filtering media, comprising: a reaction tank into which effluent wastewater of a settling basin flows; porous filtering media having predetermined sizes of surface areas and openings and filled in the reaction tank, for removing suspended solids
25 by precipitating suspended solid particles included in the effluent wastewater and removing organic matters and nutritive salts included in the suspended solid particles along with the precipitation removal of the suspended solid particles.

30 In accordance with one aspect of the present invention, there is provided a sewage tertiary treatment apparatus, wherein the reaction tank includes: a fore reaction tank, which is filled with the porous filtering media, for collecting the effluent wastewater from the settling basin
35 and performing precipitation based on biological, physical and chemical reactions; a rear reaction tank filled with a predetermined size of porous filtering media, for re-

treating the effluent water from the fore reaction tank; a discharging tank provided with an overflow weir on one side of the upper part of the efflux portion, for retaining and discharging the secondary effluent water from the rear
5 reaction tank; and rectifying walls having a plurality of efflux openings for partitioning the fore reaction tank, rear reaction tank and discharging tank.

The technology of the present invention can remove the organic matters and nutritive salts included in the
10 effluent wastewater from a settling basin by using porous filtering media and optimizing physical, chemical and biological reactions. In the physical aspect, the technology of the present invention increases the efficiency of precipitating the suspended solid particles
15 by maximizing the effective surface area of the porous filtering media filled in the reaction tank. Along with the precipitating removal of the suspended solids, the organic matters and nutritive salts included in the suspended solids are removed.

20 In the biological aspect, the technology of the present invention forms a high-density microorganism membrane on the surface of the porous filtering media filled in the reaction tank and increases the processing efficiency of the low-density organic matters included in
25 the effluent wastewater from the settling basin. Also, if the microorganism membrane method (fixed growth) is used, the surplus organic matters that cannot be removed in the suspended microorganism method (suspended growth) can be removed easily.

30 In addition, in the present invention, chemical method is used additionally. In other words, a coagulant or an apparatus for injecting highly pure oxygen or ozone is added to promote the physical and biological processing efficiency. Here, if a coagulant is used, the
35 precipitation efficiency of suspended solids is improved, and if ozone or highly pure oxygen is injected, the oxygen transmission rate is increased, and thus the biological

action can be enhanced remarkably.

In accordance with one aspect of the present invention, there is provided a method for performing a tertiary treatment of sewage using porous filtering media, comprising the steps of: a) collecting the effluent wastewater from a settling basin, flowing the effluent wastewater through porous filtering media having predetermined sizes of surface areas and openings and filled in a fore reaction tank, and processing suspended solids and organic matters based on biological, physical and chemical reactions; b) taking in the rear reaction tank the effluent water cleaned in the fore reaction tank, flowing the cleaned water through the porous filtering media having predetermined sizes of surface areas and openings and filled in the rear reaction tank, and removing suspended solids and organic matters based on biological, physical and chemical reactions; and c) retaining the water discharged from the rear reaction tank in the discharging tank and discharging the water through an overflow weir.

Meanwhile, the sewage treatment method of the present invention further includes a step of inducing phosphorous removal and denitrification reactions by supplying a coagulant and highly pure oxygen or ozone to remove the phosphorous and nitrogen included in the effluent water simultaneously as well as suspended solids and organic matters.

Brief Description of Drawings

The above and other objects and features of the present invention will become apparent from the following description of the preferred embodiments given in conjunction with the accompanying drawings, in which:

Fig. 1 is a perspective diagram illustrating a tertiary sewage treatment apparatus using porous filtering media in accordance with an embodiment of the present invention;

Figs. 2A and 2B are diagrams describing porous filtering media, which is a major element of the present invention;

Fig. 2C is a diagram showing the porous filtering media, the surface of which is covered with precipitated sludge and on which a biological membrane is formed;

Fig. 3 is a perspective diagram describing a tertiary sewage treatment apparatus using porous filtering media in accordance with another embodiment of the present invention;

Fig. 4 is a perspective diagram showing a detailed structure of the tertiary sewage treatment apparatus using porous filtering media in accordance with the present invention;

Fig. 5 is an exemplary diagram depicting a modified reaction tank, which is a major element of the present invention; and

Figs. 6A and 6B are perspective and cross-sectional diagrams illustrating a two-step discharging unit, which is another major element of the present invention.

Best Mode for Carrying Out the Invention

Other objects and aspects of the invention will become apparent from the following description of the embodiments with reference to the accompanying drawings, which is set forth hereinafter.

Hereinafter, an embodiment of the present invention is described with reference to Figs. 1 through 6. The sewage tertiary treatment apparatus and method using porous filtering media maximizes the effective surface area by filling porous filtering media having different pore sizes from each other porous filtering media to remove the organic matter and nutritive salts included in the effluent wastewater of a settling basin simultaneously by optimizing the physical, chemical and biological reactions, and remove nitrogen and phosphorous as well simultaneously by

supplying oxygen and/or ozone the effluent wastewater from a settling basin. The technology of the present invention does not require any power source. It makes use of the principle of sedimentation by gravity, where materials fall
5 down naturally as they flow.

Referring to Fig. 1, in accordance with the embodiment of the present invention, the tertiary treatment apparatus includes: an inflow tank 1 for maintaining uniform flow of effluent wastewater from a settling basin; a reaction tank
10 2 formed in a predetermined size of a rectangle for retaining the effluent wastewater of the settling basin discharged from the inflow tank 1; porous filtering media having predetermined sizes of surface area and openings and filled in the reaction tank 2 for precipitating suspended
15 solid particles included in the effluent wastewater and removing the organic matters and nutritive salts in the suspended solids, along with the precipitating removal of the suspended solid particles; a discharging tank 5 for discharging the effluent water from the reaction tank 2;
20 porous rectification walls 4 for partitioning the inflow tank 1, reaction tank 2 and discharging tank 5, respectively; and an overflow weir formed in the upper surface of the discharging tank 5 for discharging the water purified in the discharging tank 5 uniformly.

25 In the present embodiment, the porous filtering media 3 are formed of plastics or waste plastics. The porous filtering media 3 may be formed in the shape of coil spring, as illustrated in Fig. 2A, or in the shape of a ring with both ends going amiss, as shown in Fig. 2B.

30 When the porous filtering media 3 of the above shapes are filled in the settling basin, sludge is precipitated on the surface of the porous filtering media 3 to form a biological membrane thereon, as described in Fig. 2C.

In addition, the size of the porous filtering media 3
35 filled in the reaction tank 2 is 10 ~ 300 mm and their opening rate is 50 ~ 90%. The porous filtering media 3 should maintain a large surface area with high opening rate.

Desirably, the size of the filtering media is 10 ~ 300 mm. Since the present invention makes use of the principle of natural falling by gravity while flowing without any additional energy source from the outside, it is important
5 to minimize the head loss of the reaction tank 2. Also, the size and opening rate of the filtering media are restricted to 10 ~ 300mm and 50 ~ 90%, respectively, in order to remove the precipitated sludge between the openings of the porous filtering media 3.

10 In the embodiment of the present invention, the size of filtering media filled in the reaction tank 2 becomes bigger, as it goes from the upper part to the lower part of the reaction tank 2. This is to precipitate the sludge easily in the lower part of the reaction tank where the
15 load of suspended solids is relatively high.

Referring to Fig. 3, another embodiment of the present invention is described. As illustrated in the drawing, the sewage tertiary treatment apparatus includes: an inflow tank 1 for collecting the effluent wastewater from the
20 outside in a sewage disposal plant; a fore reaction tank 7, which is formed one side of the inflow tank 1 and filled with 50 ~ 300 mm of porous filtering media, for treating the effluent wastewater from the inflow tank 1 through biological, physical and chemical reactions; a rear
25 reaction tank 8 filled with 10 ~ 200 mm of porous filtering media, for re-treating the effluent water from the fore reaction tank 7; a discharging tank 5 provided with an overflow weir 6 in the upper part, for retaining and discharging the effluent water from the rear reaction tank
30 8; and porous rectifying walls 4 having a plurality of efflux openings for partitioning the inflow tank 1, fore reaction tank 7, rear reaction tank 8 and discharging tank 5.

If the reaction tank is divided into a fore reaction
35 tank 7 and a rear reaction tank 8, as illustrated in Fig. 3, the pollutant removal efficiency and the water transmission capacity of the reaction tank can be improved by

differentiating the size of porous filtering media 9 and 10 filled in the fore and rear reaction tanks 7 and 8. That is, the concentration of the suspended solids coming into the fore reaction tank 7 is higher than that of the
5 suspended solids coming into the rear reaction tank 7. Therefore, 50 ~ 300 mm of filtering media is supplied to the fore reaction tank 7, and to the rear reaction tank 8, 10 ~ 200 mm of filtering media is supplied.

In the present embodiment, the fore reaction tank 7
10 and the rear reaction tank 8 are formed of an overflowing precipitation and biological filtering basin, and the porous filtering media 9 and 10 are formed of plastics or waste plastics molded into predetermined shapes, that is, into a coil spring shape or a ring with both ends going
15 amiss, as shown in Figs. 2A and 2B.

In the present embodiment, sludge can be removed easily by filling the porous filtering media 9 or 10 of smaller size in the fore part of each reaction tank 7 and 8 and larger size, in the rear part, or the porous filtering
20 media 10 or 9 of larger size in the fore part of each reaction tank 7 or 8 and smaller size, in the rear part. This way, the suspended solids could be precipitated more in the fore part of each reaction tank 7 and 8 and less in the rear part. Here, the opening rate of the porous
25 filtering media 9 and 10 filled in the fore and rear reaction tanks 7 and 8 is 50 ~ 90%.

Besides, the sludge in the reaction tanks 7 and 8 can be removed easily by differentiating the size of the porous filtering media 9 and 10 according to the depth of the
30 reaction tanks 7 and 8. In other words, by filling the porous filtering media 9 and 10 of smaller size in the upper part and those of larger size in the lower part of the reaction tanks 7 and 8 so that the sludge could be precipitated in the lower part of a reaction tank whose
35 load of suspended solids is relatively higher than the other.

This embodiment of the present invention further

includes a sludge retention tank 11 at a predetermined position of the bottom surface of the fore and rear reaction tanks 7 and 8 to remove the sludge produced during the sewage treatment process effectively, as shown in Fig. 4; and an air supplier 12 and a supersonic generation unit 13 to remove the sludge stuck to the filtering media in the retention tank 11 effectively. In the present embodiment, suspended solids and microorganisms are precipitated on and attached to the surface of the porous filtering media 9 and 10 filled in the fore and rear reaction tanks 7 and 8, while the effluent water is processed. Then, as time passes, sludge overly precipitated and grown is slide down and slough off and accumulated in the lower part of the reaction tanks 7 and 8 according to the principle of gravity.

Referring to Fig. 5, the area 14a of the influx portion of the fore reaction tank 7 is formed larger than the area 14b of the efflux portion of the rear reaction tank 8 to make the current run at a uniform speed in the fore and rear reaction tanks 7 and 8. Considering the decrease in the cross-section area caused by the sludge precipitation in the fore reaction tank 7, the apparatus of the present embodiment is formed in a structure that can prevent unequal speed of the current. If sludge is precipitated in the fore reaction tank, the water transmission capacity can be deteriorated. However, the structure of the present embodiment makes it possible to maintain the facility smoothly and keep the processing efficiency continuously.

Referring to Figs. 6A and 6B, the present embodiment suggests a structure where the efflux portion of the rear reaction tank 8 is divided into upper and lower parts. That is, an additional upper rectifying wall 15 is further formed in the middle of the porous rectifying wall 4 extending toward the inner side of the rear reaction tank 8. The porous rectifying wall 4 partitions the rear reaction tank 8 and the discharging tank 5. Then, the dead space of

the fore and rear reaction tanks 7 and 8 is minimized by flowing the water from the upper influx portion of the rear reaction tank 8 to the upper efflux portion and flowing the water from the lower influx portion of the rear reaction tank 8 to the lower efflux portion.

Meanwhile, although the embodiments of the present invention shows porous filtering media 9 filled in the fore reaction tank 7, the technology of the present invention is not limited to the embodiments only, but it can use aluminum sulfate, iron salt, lime and polymer coagulant instead of the porous filtering media 9, or it may include a unit for injecting highly pure oxygen or ozone to maximize the sewage removal efficiency.

Hereinafter, the sewage tertiary treatment method is described, taking the sewage treatment apparatus of Fig. 3 as an example. In the present invention, what should be removed from the sewage are suspended solids, organic matters and nutritive salts such as nitrogen and phosphorous. The method is based on the principle of natural falling while flowing without requiring any external power source.

In other words, the effluent wastewater of the sewage disposal plant flows into the inflow tank 1 and is retained in the fore reaction tank 7. Then, it passes through the porous filtering media 9 and 10 having predetermined sizes of surface area and openings filled in the fore reaction tank 7 to precipitate and resolve the suspended solids and organic matters remaining in the sewage based on physical and biological reactions. Along with the removal of the suspended solids, a small amount of organic matters and nutritive salts included in the suspended solids are removed as well. The sewage processing efficiency can be maximized by adding a coagulant, together with the porous filtering media, or injecting highly pure oxygen or ozone to the fore reaction tank 7.

The suspended solids, organic matters, nitrogen and phosphorous are removed in the fore and rear reaction tanks

7 and 8 based on the following principles and methods.

First, the suspended solids are removed by using the following principle and method. The particles remaining in the effluent wastewater of the settling basin after passing through a biological process are living or dead microorganisms, pin-floc and unprocessed colloid. These materials cause turbidity. The suspended solids are removed by being precipitated on the surface of the porous filtering media 9 and 10 having large surface areas. The particles that have passed through the porous filtering media 9 and 10 cause local turbulences, and as a result, the collisions between the particles are increased. The collision and attachment reactions are performed repeatedly on the surface of the filtering media to thereby increase the size and density of the particles, and the thickening and compression are repeated on the surface of the filtering media. The minute particles still remaining after passing through the porous filtering media pass through a filtering media layer and the thickened sludge subsequently, and then they are removed by being strained out and intercepted.

Now, the principle and method of removing organic matters in the fore and rear reaction tanks 7 and 8 will be described.

The effluent wastewater of the settling basin includes suspended solids of living or dead microorganisms, and dissolved organic matters which are not removed yet. Here, the organic matters are removed in two ways. First, the organic matters included in the suspended solids are removed by getting rid of the suspended solids in the reaction tanks. The dissolved organic matters, which are not processed yet, are removed by aerobic or anaerobic biodegradation performances of the microorganisms attached to the surface of the filtering media. The amount of the sludge precipitated in the reaction tanks is reduced by biodegradation. In case where a biological membrane method is used, the sludge age of the precipitated sludge, i.e.,

solids retention time (SRT), becomes much longer than the suspended growth time. So, the sludge in the reaction tanks is digested by itself and thus the amount of sludge is reduced remarkably.

5 In accordance with the present invention, nitrogen is removed in the fore and rear reaction tanks 7 and 8 based on the following principle and method.

10 In the effluent wastewater of the settling basin, nitrogen exists mainly in the forms of $\text{NH}_4^+\text{-N}$, $\text{NO}_3^-\text{-N}$ and organic-N. Among them, $\text{NH}_4^+\text{-N}$ is used for synthesizing cells through microorganism metabolism, and at the same time, it is converted into NO_3^-N through a nitrification process. The nitrogen of NO_3^-N can be removed, as NO_3^-N is denitrified by a microorganism under anaerobic condition
15 and then converted into N_2 gas. Physical methods such as filtering and adsorption are effective in removing organic nitrogen existing in the form of particles, but it cannot remove materials with high dissolution, e.g., ammonia or nitrate.

20 In the present invention, the nitrification reaction occurs additionally by the high-density biological membrane formed in the fore reaction tank 7, and as it goes to the rear part, anaerobic condition is made, and thus denitrification reaction is expected to occur due to the
25 denitrifying microorganism which uses the remaining organic matters.

The nitrogen and phosphorous included in the suspended solids are removed as the sludge precipitated in the fore and rear reaction tanks 7 and 8 periodically.

30 In addition, the present invention induces the oxidation and nitrification of the organic matters by supplying highly pure oxygen, which will become dissolved oxygen later, in the fore reaction tank 7, and induces denitrification reaction in the rear reaction tank 8 to
35 convert them into N_2 gas.

If ozone (O_3) is supplied, the biodegradation of the organic matters which are hard to be decomposed is promoted.

Thus, the organic matter and the coagulated pin-floc can be removed efficiently. Also, nitrification is induced and denitrification in the rear reaction tank is promoted additionally.

5 Phosphorous in the fore and rear reaction tanks 7 and 8 is removed based on the following principle and method. Phosphorous in the effluent wastewater of the settling basin exists in the form of dissolved $\text{PO}_4^{-3}\text{-P}$ and in the state of solid included in the cells of microorganism. The
10 part of the dissolved phosphorous is removed by the synthesis of microorganism cells. That is, the biological removal of phosphorous is performed based on the metabolism of microorganism under aerobic/anaerobic condition. The phosphorous can be removed by getting rid of extra sludge,
15 when phosphorous is overly taken into cells under an aerobic condition. The solid state of phosphorous is removed precipitated by the filtering media. Phosphorous can be removed effectively using a coagulation and precipitation method. As for the coagulant, aluminum
20 sulfate, iron salt, lime and polymer coagulant may be used. Phosphate is precipitated in the forms of AlPO_4 , FePO_4 , $\text{Ca}_5(\text{OH})(\text{PO}_4)_3$ by the metallic ions of the coagulant. Organic phosphorous in the form of organic particles can be precipitated here, too.

25 As described above, when the coagulant is put into the inflow tank 1 in accordance with the present invention, the suspended solids can be removed effectively and the dissolved phosphorous can be coagulated efficiently and then precipitated.

30 In addition, the technology of the present invention can clean and remove the sludge attached on the porous filtering media in the fore and rear reaction tanks 7 and 8 periodically.

35 The technology of the present invention can maximize the precipitation of the suspended solids included in the discharged water due large opening and high opening rate, compared to other conventional methods such as sand

filtering. So, it is possible to perform a tertiary treatment of sewage efficiently and use the cleaned water for a wastewater reclamation and reusing system. Moreover, compared to common filtering methods, the technology of the present invention has the less clogged openings, and consumes less amount of power due to the remarkably long back-washing period. Due to the small specific gravity of the waste plastics or plastics used as porous filtering media, it is easy to maintain the sewage treatment facility and it has an effect of resource recycling.

While the present invention has been described with respect to certain preferred embodiments, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. An apparatus for performing a tertiary treatment of sewage using porous filtering media,
5 comprising:

a reaction tank into which effluent wastewater of a settling basin flows;

porous filtering media having predetermined sizes of surface areas and openings and filled in the reaction tank,
10 for removing suspended solids by precipitating suspended solid particles included in the effluent wastewater and removing organic matters and nutritive salts included in the suspended solid particles along with the precipitation removal of the suspended solid particles.

15

2. The apparatus as recited in claim 1, further comprising:

an overflow weir installed in the upper surface of the efflux portion of the reaction tank, for discharging
20 the water cleaned in the reaction tank to the outside.

3. The apparatus as recited in claim 1, wherein the porous filtering media are formed of waste plastics or plastics having a size of 10 ~ 300mm.

25

4. The apparatus as recited in claim 1, wherein the small size of the porous filtering media are filled in the upper part of the reaction tank, and the size of the porous filtering media becomes larger as it goes to the
30 lower part of the reaction tank.

5. The apparatus as recited in claim 1, wherein the opening rate of the porous filtering media filled in the reaction tank is 50 ~ 90%.

35

6. The apparatus as recited in claim 1, wherein the reaction tank includes:

a fore reaction tank, which is filled with the porous filtering media, for collecting the effluent wastewater from the settling basin and performing precipitation based on biological, physical and chemical reactions;

5 a rear reaction tank filled with a predetermined size of porous filtering media, for re-treating the effluent water from the fore reaction tank;

a discharging tank provided with an overflow weir on one side of the upper part of the efflux portion, for
10 retaining and discharging the secondary effluent water from the rear reaction tank; and

rectifying walls having a plurality of efflux openings for partitioning the fore reaction tank, rear reaction tank and discharging tank.

15

7. The apparatus as recited in claim 6, wherein the filtering media filled in the fore reaction tank are formed of a predetermined size of porous filtering media.

20

8. The apparatus as recited in claim 6, wherein the filtering media filled in the fore reaction tank are formed of any one selected from a group consisting of aluminum sulfate, iron salt, lime and polymer coagulant.

25

9. The apparatus as recited in claim 6, further including:

a highly pure oxygen injection means, installed in the lower part of the fore reaction tank, for inducing phosphorous removal and denitrification.

30

10. The apparatus as recited in claim 6, further including:

an ozone injection means, installed in the lower part of the fore reaction tank, for inducing phosphorous
35 removal and denitrification.

11. The apparatus as recited in claim 9, wherein

the diameter of the porous filtering media in the fore reaction tank is 50 ~ 300 mm.

12. The apparatus as recited in claim 6, wherein
5 the diameter of the porous filtering media in the rear reaction tank is 10 ~ 200 mm.

13. The apparatus as recited in claim 6, wherein
the opening rate of the porous filtering media filled in
10 the fore and rear reaction tanks is 50 ~ 90%.

14. The apparatus as recited in claim 6, wherein
the porous filtering media are formed of plastics including
waste plastics.

15

15. The apparatus as recited in claim 6, wherein
the size of the porous filtering media in the fore part of
the rear reaction tank is large, and the size of the porous
filtering media becomes smaller as the porous filtering
20 media goes to the rear part.

16. The apparatus as recited in claim 6, further
including:

25 sludge retention tanks installed in the lower parts
of the fore and rear reaction tanks, respectively, for
collecting and removing the sludge produced during the
sewage treatment process.

17. The apparatus as recited in claim 6, further
30 including:

an air supplier installed in the lower part of the
rear reaction tank, for removing the sludge produced during
the sewage treatment process.

18. The apparatus as recited in claim 6, further
35 including:

a supersonic generator installed in the lower part of

the rear reaction tank, for removing the sludge produced during the sewage treatment process.

19. The apparatus as recited in claim 6, wherein
5 the area of the influx portion of the fore reaction tank is formed larger than the area of the efflux portion of the rear reaction tank to make the speed of a current uniformly distributed in the fore and rear reaction tanks.

10 20. The apparatus as recited in claim 6, further including:

an upper rectifying wall, which has a plurality of efflux openings and is extended to the inner side of the rear reaction tank from a predetermined area of the
15 rectifying wall that partitions the rear reaction tank and the discharging retention tank, for minimizing the dead space area of the rear reaction tank.

21. A method for performing a tertiary treatment of
20 sewage using porous filtering media, comprising the steps of:

a) collecting the effluent wastewater from a settling basin, flowing the effluent wastewater through porous filtering media having predetermined sizes of surface areas
25 and openings and filled in a fore reaction tank, and processing suspended solids and organic matters based on biological, physical and chemical reactions;

b) taking in the rear reaction tank the effluent water cleaned in the fore reaction tank, flowing the
30 cleaned water through the porous filtering media having predetermined sizes of surface areas and openings and filled in the rear reaction tank, and removing suspended solids and organic matters based on biological, physical and chemical reactions; and

35 c) retaining the water discharged from the rear reaction tank in the discharging tank and discharging the water through an overflow weir.

22. The method as recited in claim 21, further comprising a step of:

d) removing nitrogen and phosphorous included in the suspended solids by getting rid of the sludge precipitated
5 in the fore and rear reaction tanks periodically.

23. The method as recited in claim 21, further comprising a step of:

e) inducing the oxidation and nitrification of the
10 organic matters by supplying dissolved oxygen to the fore reaction tank, and then promoting denitrification reaction in the rear reaction tank.

24. The method as recited in claim 21, further
15 comprising a step of:

f) removing the organic matters by supplying ozone (O_3) to the fore reaction tank to promote the biodegradation of the organic matters which are not decomposed easily, increasing the efficiency of removing
20 coagulated particles and inducing nitrification, and promoting denitrification in the rear reaction tank.

25. The method as recited in claim 21, further comprising a step of:

g) coagulating and precipitating the dissolved phosphorous by adding a coagulant to the fore reaction tank to increase the effect of removing the suspended solids.

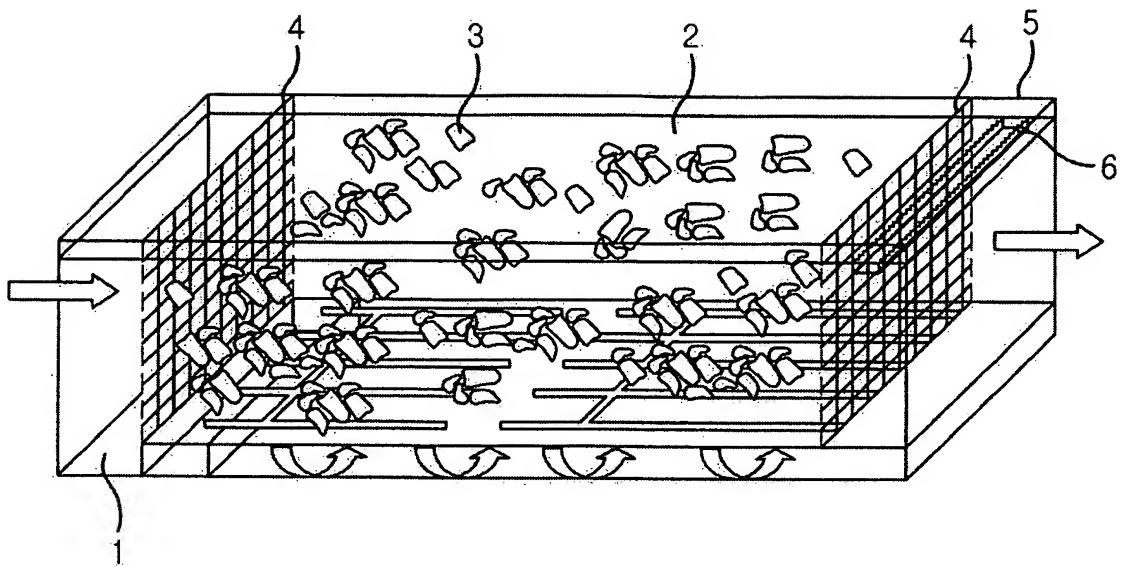
26. The method as recited in claim 21, further
30 comprising a step of:

h) cleaning and removing the sludge attached on the porous filtering media periodically by providing air or supersonic from the lower part to the upper part of the fore and rear reaction tanks.

Abstract

Provided is an apparatus and method for performing tertiary treatment of sewage based on porous filtering media. The apparatus for performing tertiary treatment of sewage based on porous filtering media includes a reaction tank for receiving effluent wastewater from a primary settling tank; and porous filtering media, which is located in the reaction tank and has a predetermined size of surface area and opening, for settling suspension in the effluent wastewater and removing organic matter and nutritive salts included in the suspension.

FIG. 1



BEST AVAILABLE COPY

FIG. 2A



FIG. 2B

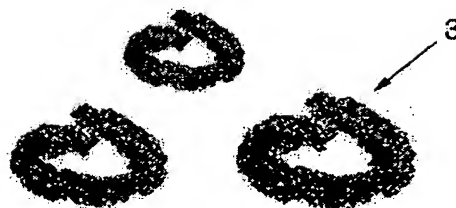


FIG. 2C

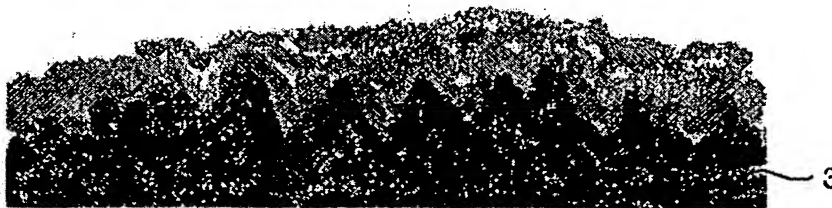


FIG. 4

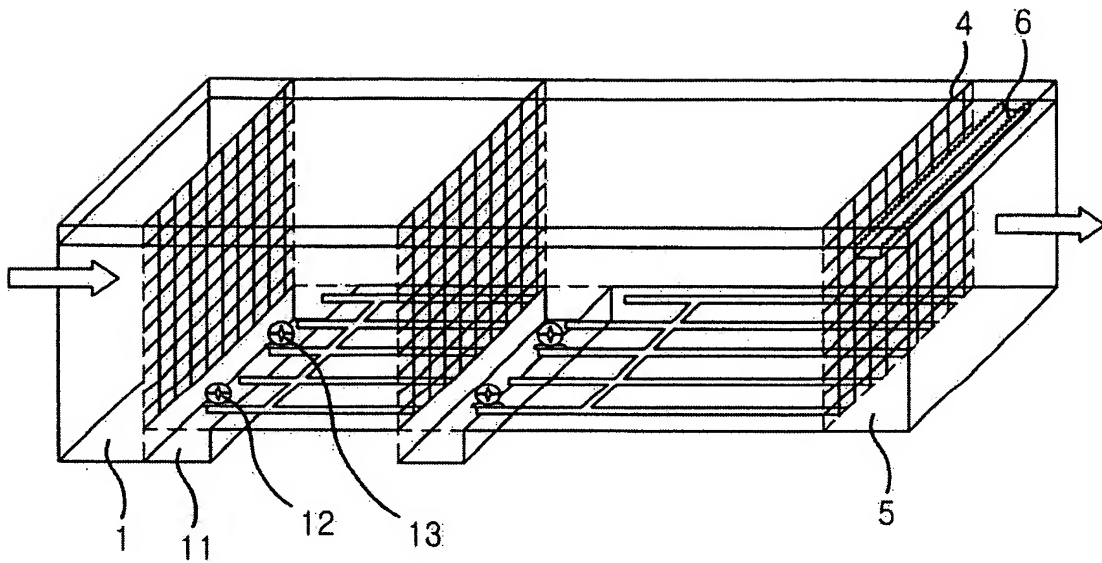


FIG. 5

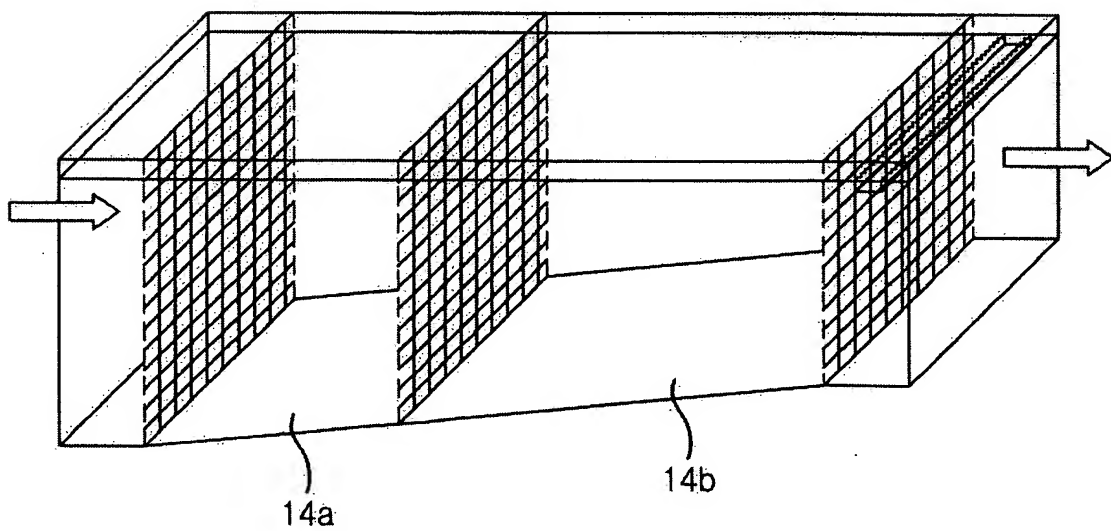


FIG. 3

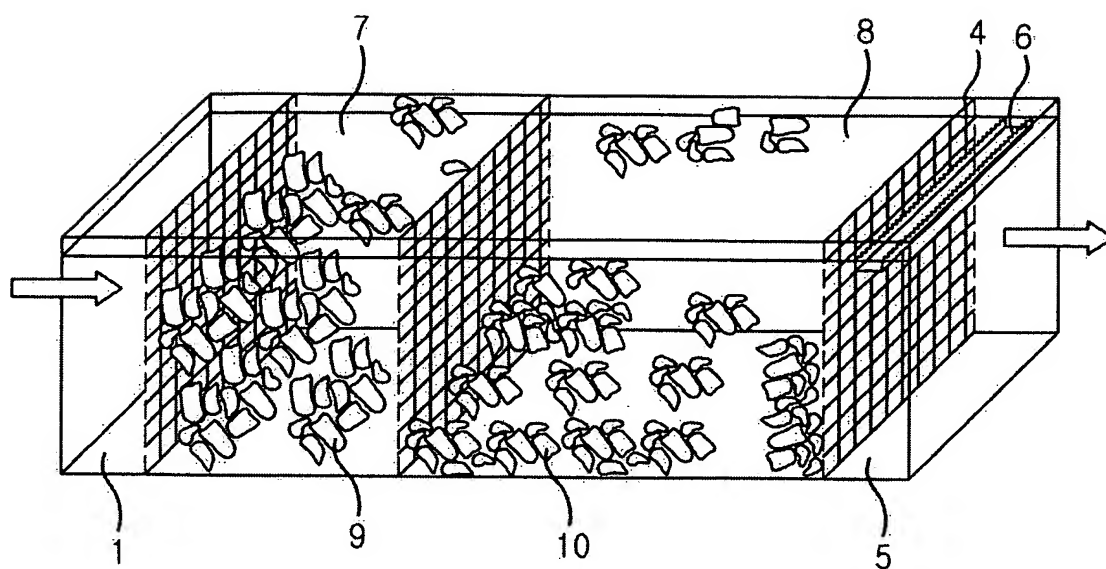


FIG. 6A

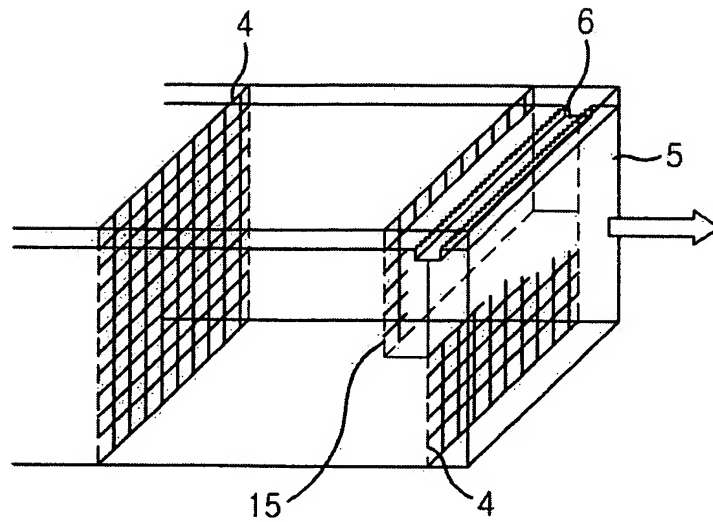
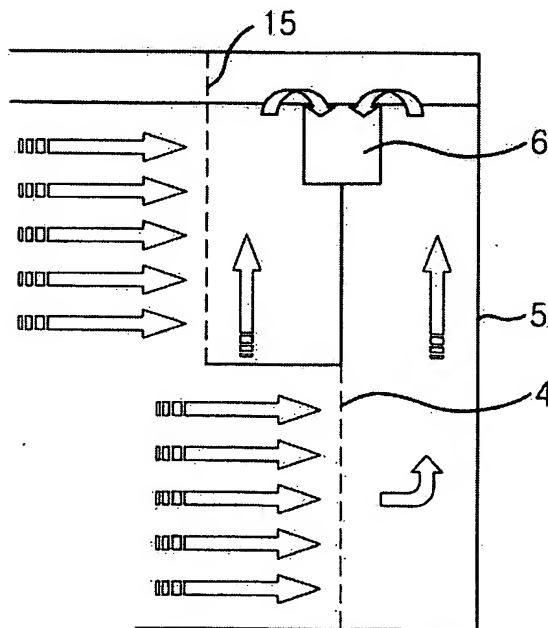


FIG. 6B



BEST AVAILABLE COPY

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 C02F 3/06, C02F 3/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 A01K, B01D, C01B, C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Korean Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS, DELPHION, PAJ, ESPACENET

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 882676A1 (NKK Corporation) 09 DECEMBER 1998 See page 6, line 37 ~ 45 ; page 7, line 38 ~ 47 ; page 11, line 8 ~ 21 ; page 13, line 36 ~ 49 See figure 10c, 13a	1, 6, 7, 17, 21, 23
Y ----- A	JP 62083093A (SHIMIZU Constr. Co., Ltd.) 16 APRIL 1987 see the whole document	1, 6, 7, 17, 21, 23 ----- 20
A	US 5387335A (ISAMU IWAI et al.) 07 FEBRUARY 1995 See column 5, line 31 ~ 44 See figure 1	16
A	WO 8602630 (TRIMMEL et al) 09 MAY 1986 See the whole document	18, 26
A	KR 98085026 (SAMSUNG HEAVY INDUSTRIES Co., Ltd.) 05 DECEMBER 1998 See abstract	9, 10, 24


☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
25 AUGUST 2003 (25.08.2003)

Date of mailing of the international search report
26 AUGUST 2003 (26.08.2003)

Name and mailing address of the ISA/KR
 Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
LEE, Jin Yong
Telephone No. 82-42-481-8116



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR02/02268

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 882676 A	09-12-1998	WO 9818728 A1 TW 0442443 B SG 0084564 A1 JP 11070391 A2 JP 11070390 A2 JP 11042492 A2 JP 10128361 A2 JP 10128360 A2	07-05-1998 23-06-2001 20-11-2001 16-03-1999 16-03-1999 16-02-1999 19-05-1998 19-05-1998
JP 62083093 A	16-04-1987	JP 62083093 A2	16-04-1987
US 5387335 A	07-02-1995	WO 9209533 A1 US 5387335 EP 0558745 A4 CA 2096523 AA AU 6733390 A1	11-06-1992 07-02-1995 08-12-1993 22-05-1992 25-06-1992
WO 8602630	09-05-1986	NONE	
KR 98085026	05-12-1998	NONE	